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SECTION A - SUPPLEMENTAL INFORMATION

PROGRAM: Ph II SBIR, Compact Turbochargers for Military Diesel Engines

PURPOSE OF MODIFICATION: Authorize Use of Government Furnished Material (JP-8 fuel)

PREVIOUS NEGOTIATED CONTRACT VALUE:	Estimated Cost:	\$684,292.00
	Fixed Fee:	44,479.00
	Total Cost:	\$728,771.00
NEGOTIATED VALUE THIS ACTION:		\$ -00-
TOTAL NEGOTIATED CONTRACT VALUE:		\$728,771.00

PREVIOUS OBLIGATED CONTRACT AMOUNT:	\$364,743.00
OBLIGATED AMOUNT THIS ACTION:	\$ -00-
TOTAL OBLIGATED CONTRACT AMOUNT:	\$364,743.00

1. The purpose of this bilateral modification P00001 is to add FAR clause 52.251-1, "Government Supply Sources" to the contract.
2. The contract is modified as follows:

Section C:

- Paragraph C.5.2 is modified to add testing with JP-8 fuel.
- Paragraph C.5.3 is modified to add testing with JP-8 fuel.

Section I:

- FAR Clause 52.251-1 is added.

3. The contract obligation is not increased by this modification.
4. The negotiated value of the contract remains unchanged.
5. Except as provided herein, all other terms and conditions of Contract W56HZV-05-C-0760 remain unchanged.

*** END OF NARRATIVE A0001 ***

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SECTION C - DESCRIPTION/SPECIFICATIONS/WORK STATEMENT

Description/Specification/Work Statement

C.1 Background: The purpose of this research effort is for the contractor to advance the technology of diesel engine design and improve its performance. The candidate engine for this R & D work is the Cummins ISB-305, in-line 6 cylinder. A second purpose of this research work is for the contractor to conduct R & D work on the 6.5 L, V8 diesel engine for military HMMWV program to improve its performance. Increased HMMWV deployed vehicle weight, combined with extreme ambient temperature and difficult terrains operating conditions, has marginalized vehicle design performance, and necessitated design changes to improve its performance. The results of the research work could end up in potential application on future Government vehicles of traditional and hybrid configurations.

C.2 Scope of Work: The contractor, as an independent contractor and not as an agent of the Government shall provide the necessary facility material, personnel, equipment, and services to achieve the tasks as defined in this Scope of Work.

C.3 Cummins ISB 305 engine: The contractor shall modify the design of the Cummins ISB 305 engine (provided as GFP, reference paragraph H.1), equip engine with advanced materials and components, and demonstrate the technology for performance on a dynamometer laboratory test rig. The technology demonstrator engine power goal is to increase the engine power from 305 hp to 500 hp.

C.3.1 The contractor shall compute, model, and design the modified engine of paragraph C.3 to meet/exceed the following performance ratings:

The ratio of power/engine weight = 0.95 to 1.15 hp/lb
The ratio of power/engine volume = 28 to 38 hp/ft^3
The ratio of power/propulsion system volume =6 to 8 hp/ft^3
Specific fuel consumption, BSFC = 0.32 to 0.38 lb/hp-hr
Brake mean effective pressure, BMEP = (18 25) bar
Specific heat rejection to coolant and oil= (14 20) btu / hp-min
Super-turbocharger compressor output pressure (boost), 4.5bar
Air/fuel ratio (17 to 22)/1 -----CI/Diesel combustion
Fuel injection pressure, 23500 to 30000 psi

C.3.2 The contractor shall conduct engine simulation modeling and material analysis to determine the thickness of the low heat rejection (LHR) thermal barrier and low coefficient of friction, low wear coatings of the engine cylinder head, liner, and rings. The analysis shall include stress and heat transfer of the engine components. In addition, the contractor shall model the combustion chamber components including the intake and exhaust valves. This simulation work shall determine the material constraints versus working temperature and the method of coatings and insulation of the pistons, liners, rings, and valves.

C.3.2.1 The contractor, at any time during the contract period, and with the agreement and approval of the Contracting Officer Representative, shall include in the engine design, a new, high technology, cost effective material, insulation, or designs that could improve the engine performance and decrease its weight, cost, and contribute to approaching the LHR demonstrator engine requirements in accordance with paragraph C.3. and C.3.1.

C.3.2.2 The contractor shall equip the instrumented test engine demonstrators with pressure transducers, thermocouples, and computer system, and collect data for cylinders variable pressure, and temperature data of rings, liner, coolant, oil sump, and exhaust gases. Data for pressure- volume, and temperature entropy diagrams with graphical interface shall be projected on the computer monitor, The diagrams shall show the 4 major processes of the compression- ignition diesel cycle of intake, compression, (ignition - combustion- expansion), and exhaust.

Using the pressure volume diagram of the new modified engine demonstrator, the contractor shall compute the engine data indicated, and the brake mean effective pressures, brake horsepower, specific fuel consumption, and torque at 100%, and 50% of engine load-speed. The contractor shall use a TACOM generated and validated engine model to compute the engines performance parameters.

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C.3.2.3 The contractor shall incorporate into the modified engine designs a 4 stroke thermodynamics (mechanical) compression-ignition diesel cycle, compression ratio of 15/1 minimum, high pressure common rail advanced fuel injection system, latest in technology in super-turbo-charging, compressed induction air cooling, optimized injection timing, optimized air-fuel ratio, low heat rejection thermal barrier coating upper ring and over all engine tribology lubrication and cooling, low coefficient of friction and wear coatings, cylinder bore hot honing, and aluminum alloy technologies, and meet the requirements of paragraph C.3. and C.3.1. The contractor shall analyze the fuel injection system and air flow demand of this new Low Heat Rejection Engine demonstrator. The contractor shall optimize the volumetric efficiency to its highest possible peak by providing efficient engine design in the area of valve/cam timing, fuel injection timing, and turbo-supercharged air intake high boost.

In addition, the contractor shall perform analysis of the Low Heat Rejection Engine energy balance, heat release, and other operating parameters. Instrumentation of the engine and measurement of fuel injection pressure, timing, engine temperature, pressures, airflows, and fuel consumption shall be made, collected and analyzed. The purpose of this analysis is to help to calculate the effectiveness of the thermal barrier coatings (TBC), the tribology coatings, boundary lubrication, friction and wear at high temperature operation.

C.3.2.4 The contractor shall procure optimized coatings, advanced technology turbo-charging, and high pressure fuel injection system for incorporation into the final multi-cylinders Low Heat Rejection engine demonstrator. It is expected that the LHR engine demonstrator will meet or approach the requirements in accordance with paragraph C.3., and C.3.1.

C.3.2.5 The contractor shall conduct performance, and endurance tests in accordance with paragraphs C.5, C.5.1, C.5.2, C.5.3, C.5.4, and, C.6.4

C.3.2.6 The contractor shall report on the progress made on the engine work in accordance with paragraphs C.6, C.6.1, C.6.2, and C.6.3

C.4 HMMWV 6.5 L. V8 engine program:

The contractor is to modify/redesign the 6.5 L. V8 turbocharged Diesel engine (contractor furnished property), as utilized in the HMMWV vehicle, to increase its power from 193 hp to a minimum of 240 hp, and to reduce the heat transfer to the engine cooling system. The coolant temperature to the radiator shall be decreased by 22 degrees F minimum.

C.4.1 The contractor shall apply advanced technologies low heat rejection thermal barrier coatings, tribology, low coefficient of friction and low wear coatings, iron titanate coatings, DLC solid lubricant, and molly spray on HMMWV engine parts and components. The parts and components, coatings and coating thicknesses, and method of applications shall be discussed with and approved by the COR.

C.4.2 The contractor shall conduct design, analysis, and study of feasibility to perform major redesign of the HMMWV engine components as follows:

- * Redesign the combustion pre-chamber to direct injection in piston chamber
- *Redesign the fuel system to a common rail fuel injection system
- *Incorporate into the engine aluminum alloy technology
- *redesign the bore to stroke ratio for improved engine performance
- *Select and match a high performance super-turbocharger with higher flow and pressure outputs
- *Efficient cooling and lubrication systems
- *compressed induction air cooling, optimized injection timing, and optimized air-fuel ratio
- * Feasibility of incorporating aluminum alloy liners into the engine

C.4.3 The contractor shall conduct performance, and endurance tests in accordance with paragraphs C.5, C.5.1, C.5.2, C.5.3, C.5.4, and, C.6.4

C.4.4 The contractor shall report on the progress made on HMMWV engine work in accordance with paragraphs C.6, C.6.1, C.6.2, and C.6.3

C.5 The Contractor shall conduct testing of the modified engines as described below.

C.5.1 Engine break-in run: The contractor shall break-in run the engines in their laboratory for 40 minutes duration at idle and at increased speed up to the rated engine speed. The contractor shall inspect the engine for any problem, and prepare it for the performance and endurance tests.

C.5.2 Performance tests: The contractor is to demonstrate the technology improvements of the new modified engine by running a dynamometer, engine tests for performance. The test plan shall be defined in an interim meeting with TACOM Contracting Officer Representative (COR). The contractor shall test the modified engine for performance at various engine loads of (100%, 80%, 60%, and 40%) and speeds. The contractor shall develop fuel map from data of BHP, BSFC, and torque. *The contractor shall conduct these tests using both DF-2 and JP-8 fuels.

C.5.3 Endurance tests: After the engine passes performance tests of paragraph C.5.2, the contractor shall test the engine for 20 hours of endurance tests at various loads and speeds. The endurance tests shall include six (6) per cent of test time at full load condition. The performance and endurance test plans are to be discussed with and approved by the COR. *The contractor shall conduct these tests using both DF-2 and JP-8 fuels.

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C.5.4 The contractor shall provide notification to the COR to attend and witness the engine tests. The contractor notification shall be extended one week prior to the starting of the test.

C.6 Reports: The contractor shall prepare technical, cost, and final reports, as well as any drawings and other technical data in the format and scope specified in the applicable data item description (DD FORM 1664). The information shall be furnished to the Government in accordance with the requirements, quantities, and schedules set forth in the Contracts Data Requirements List. (DD FORM 1423)

C.6.1 Contractor status, progress and management report: The contractor shall prepare and deliver bi-monthly contractor status, progress and management reports in accordance with CDRL item no. A001, DI-MGMT-80227 (T). In addition to cost reporting; these reports shall identify the current activities, document any problems, the causes of these problems, determine program impact, and describe actions taken to resolve those problems.

C. 6.2 Final technical report: The contractor shall prepare and deliver draft and final technical reports covering all the program activities. The final technical report shall be prepared in accordance with CDRL item no.A002, DI-MISC-80711, and shall include all test data gathered during the performance of the contract.

C.6.3 Project Summary: Contractor shall prepare and deliver a R & D Project Summary in accordance with CDRL Item A002, DI MISC-81612A (T) (see Attachment 002). Summary shall be delivered at the time of delivery of the Final Technical Report (C.6.2)

C.6.4 Test Plans: Contractor shall prepare and deliver a Test Plan for each Test and Demonstration in accordance with CDRL Item A004, DI-NDTI-80566 (see Attachment A003).

C. 7 Meetings: The contractor shall plan and coordinate with the COR the date, time and location of three meetings. The meetings shall be conducted with the COR to review progress being made on the contract.

- a) The first meeting is the kickoff meeting which shall be conducted one week after contract award, or at a date and time to be mutually agreed upon with the COR;
- b) the second meeting shall be conducted one year after contract award; and,
- c) the third meeting is the final program review meeting.

The contractor shall conduct these meetings, and shall cover all aspects of the program effort under this contract. Other meetings may be convened, as required, to plan and conduct tests and demonstrations.

C.8 Deliverables: The contractor shall deliver the completed engine(s) in final modified configuration to the Government as specified in paragraph F.3 twenty-four (24) months after contract award.

* Added by Mod P00001

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SECTION I - CONTRACT CLAUSES

Status	Regulatory Cite	Title	Date
I-1 ADDED	52.251-1	GOVERNMENT SUPPLY SOURCES	APR/1984